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CHEMICAL & ENGINEERING

NEWS

Hazardous wastes in academic labs

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Work-Force Reduction Programs Create New Employment Picture

Five years of job cuts leave employees feeling insecure; leaner chemical firms save on payroll costs but may risk losing employees' loyalty

David Webber, C&EN Washington

Du Pont made headlines last year with an early retirement incentive plan so seductive that some 11,200 salaried employees—nearly twice as many as expected—took the money and ran. The heavy acceptance rate left the company thin on key personnel in many areas. But while critics cringed, Du Pont coped and now, having taken less than a year to catch its breath, the firm is ready to begin laying off another 1000 to 2000 salaried workers.

The company's quick return to a job-slashing guise is just one more indication that the chemical industry's attack on payroll costs—especially white-collar salaries and benefits—is probably still a long way from having run its course. There were some 13,000 fewer salaried employees, including chemists and chemical engineers, working in the chemical industry at the end of 1985 than there were a year earlier, but even that large figure masks the true extent of job dislocation in white-collar ranks since companies were still hiring new salaried personnel last year. In the 13 biggest chemical firms alone, probably close to 20,000 salaried employees left their positions last year as the result of either layoffs or the acceptance of early retirement inducements.

Du Pont's plan to lay off another batch of employees over the next two years is not the only future job cut on which chemical employees can count. Dow Chemical launched programs in November aimed at trimming 2500 people from its glob-

Staffs pruned throughout chemical industry in 1985

Some companies just trimmed while others hacked away whole branches, but almost every one of the biggest employers in the chemical industry pruned its workforce in 1985. In some cases, companies offered early retirement incentive plans (ERIPs) that lured thousands of employees from all departments off the payroll. In others, limited special early retirement programs or layoffs cut staffs more selectively.

Whatever the means or reasons, the staff cuts were enough to reduce overall employment in the chemicals and allied products sector by 20,000 workers during the year, according to seasonally adjusted Labor Department statistics. A C&EN survey of a group of 13 major chemical producers, which together accounted for some 57% of chemical industry employment in 1984, shows that composite employment remained essentially unchanged in 1985, despite a number of major acquisitions.

Last year's assault on payroll was the latest surge in a battle against overhead that began, as far as personnel is concerned, after employment reached its most luxuriant growth around 1979. Between the end of that year and December 1985, total chemical employment dropped some 80,000 people, more than 7%. The size of the decrease, however, was limited by job increases in the drug and paint segments. Large work-force reductions were made in the agricultural chemicals, plastics and synthetics, and inorganic chemicals segments especially. Between the end of 1980 and the end of 1985, composite employment by the group of 13 chemical companies with the biggest payrolls fell about 84,000, or 13%.

Following are selected company-by-company reports on the employment reduction actions from C&EN's survey of the group:

American Cyanamid: The firm will lay off 400 salaried and hourly workers at its Linden, N.J., facility this year.

Dow Chemical: The company reported no layoffs in 1985, but in November offered salaried U.S. employees an ERIP that expired last week. The move, part of a $475 million restructuring of the company (C&EN, Nov. 25, 1985, page 6), is designed to lead to a worldwide employment decrease of some 2500 people. Dow's payroll grew in 1985, primarily the result of the Jan. 1, 1985, absorption of the Texize division of Morton Thiokol.

Du Pont: Companywide early retirement inducements last year lured about 11,200 salaried employees off the payroll. Another 1000 to 2000 salaried employees will be laid off over the next two years.

Ethyl Corp.: In the company's only special early retirement offer, about 150 employees at the Baton Rouge facility left. There were no layoffs.

W. R. Grace: The firm had no layoffs in 1985 and just one ERIP, a fourth-quarter offer to fewer than 150 employees of the catalyst-producing Davison division. Overall employment increased through restaurant acquisitions.

Hercules: The principal reason for the

al payroll by the end of last month. Monsanto, having reduced its work force substantially last year through layoffs and retirement incentives, still has several hundred staff members who will be laid off on March 31 or when they find a new job, whichever comes first. And Union Carbide, having hacked away thousands of jobs last year through incentives and layoffs, is widely expected to pursue another round of salaried staff cuts once the company, currently in the process of selling off some major assets, assumes its new size and shape.

The assault on the white-collar work force has been and continues to be widespread. Just last year, almost all of the 13 chemical companies with the largest employment rolls implemented reductions in force—as current personnel jargon calls them—in the form of either layoffs or special early retirement offers.

At Lamalie Associates, a New York City-based executive search firm, the number of chemical industry executives newly entered in the firm's database of people looking for jobs jumped from 96 in 1983 to 158 in 1984 to 340 in 1985. And as a sign of lowered expectations all around for future employability of professionals in the chemical industry, early predictions from academia indicate that the class of 1988 will include 5%—10%, or even a greater percentage, fewer chemists and chemical engineers than did the class of 1985.

That's quite a rapid response to the lessening demand for chemists and chemical engineers, remarks Thomas V. McCarthy, vice president of human resources at Hercules.

Analysts typically praise sharp reductions in force because they help companies both lower their break-even points and reposition their employees in higher growth areas. As such, job cuts are considered by chemical industry analysts an appropriate response to a changed business—one characterized by slow growth in traditional markets, the need to develop new value-added products, and heightened international competition. Even employees included in work-force reductions sometimes concede—if adequately mollified by a good severance package—that the action makes good business sense.

Nevertheless, observers have begun to wonder what costs might be hidden by the more evident gains of the job-cut spree. About the only truly measurable effect of large-scale work-force decreases is the reduction of payroll and related costs. The question of the morale of those who survive a job cut remains a great imponderable. Pessimists assert that the spared, fearing another round of cuts that they will fail to escape, lose spirit. Optimists claim the survivors develop a sense of belonging to the cream of the work force, and that morale rises as a result.

On the negative side, the most obvious disadvantage of large-scale job cuts is the loss of experienced personnel. "The loss of experience constitutes a disruption to the continuity of know-how in the organization," says Hercules' McCarthy.

McCarthy also points out that

decline in Hercules' work force was the sale of its explosives business. About 100 people retired in an ERIP offered in March to some 900 salaried employees.

Monsanto: Excluding the 10,970 Searle employees (June total) added to the payroll in October, Monsanto's total work force shrank nearly 5500 last year, about half through ERIPs and the rest through layoffs and attrition. Several hundred more Monsanto staff members will be laid off by March 31, and 400 to 500 Searle employees are slated to lose their jobs this year.

Olin Corp.: As part of a restructuring announced in September (C&EN, Oct. 7, 1985, page 4), the company is more than halfway through a program intended to cut 4200 people from its payroll in selected areas. Of that total, however, 3500 are attached to operations that Olin has sold or intends to sell. About 700 salaried employees with "support roles" related to those operations, a spokesman says, are in the process of being laid off. There was no ERIP. In November, Olin took over for the federal government operation of the Lake City Army Ammunition plant in Independence, Mo. That added about 3000 workers to company rolls. Factoring out that addition, Olin's work force shrank about 21% last year.

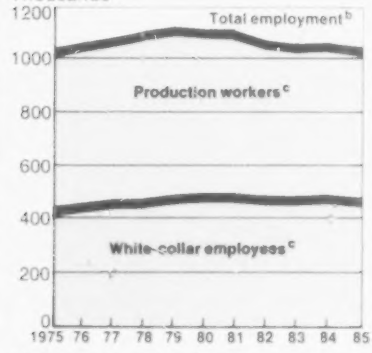
PPG Industries: The company quietly laid off at least 352 employees last year (168 of them salaried) in several actions (C&EN, Dec. 9, 1985, page 6).

Union Carbide: About 7800 U.S. and Puerto Rican employees left the company, and perhaps more than 3000 overseas employees did, too. The company, having scheduled a slew of asset sales in 1986, will be a much smaller enterprise by midyear. Analysts expect another round of staff reductions once the current consolidation is completed.

Company	Total employment[a]			% change		Cut staff in 1985 by[f]	
	1985[b]	1984	1980	1984–85	1980–85	Layoffs	ERIP[c]
Air Products[d]	18,700	17,700	15,800	6%	18%		
American Cyanamid	38,762	38,157	42,600	2	−9	X	
Celanese	19,000	21,500	36,500	−12	−48		X
Dow Chemical	53,303	49,800	56,800	7	−6		X
Du Pont[e]	117,000	124,893	136,259	−6	−14		X
Ethyl	10,574	11,081	15,000	−5	−30		X
W. R. Grace	90,000	80,000	91,700	13	−2		X
Hercules	25,448	26,262	22,900	−3	11		X
Monsanto	56,112	50,754	61,800	11	−9	X	X
Olin	17,000	17,800	21,000	−4	−19	X	
PPG Industries[f]	37,500	37,700	37,300	−1	1	X	
Rohm & Haas	11,898	11,911	13,200	0	−10		
Union Carbide[g]	87,500	98,366	116,100	−11	−25		X
TOTAL	582,797	585,924	666,959	−1%	−13%		

a As of year's end unless noted otherwise. b Preliminary figures. c Early retirement incentive program. d As of end of each fiscal year (Sept. 30). e Excludes Conoco. f Annual averages. g Estimate.

Salaried workers not spared as chemical employment fell



a Seasonally adjusted for December of each year unless noted otherwise. b Chemicals and allied products employment. c Latest available 1985 figure is for November. **Source:** Labor Department

though job cuts can be seen, in the positive viewpoint, as ways to open career avenues for younger employees, the reductions also mean that there are fewer positions that can be used to develop high-potential executives.

Also, points out Salomon Brothers analyst Leslie Ravitz, excessive cuts can potentially hamper a company's efforts to develop new products. "If you pull people out of R&D and technical service, you could miss opportunities," he says.

Employment experts also note that even after a reduction in force is completed, firms can remain at risk in terms of adequate staffing and experience. "Many companies have taken away as much fat as they can," comments John F. Johnson, president of Lamalie Associates. "There are fewer backups for key jobs. Companies have to recognize that, in many cases, if something happens to an individual in a critical role, they may have to go outside the company."

Perhaps the most imponderable aspect of the most recent spate of work-force reductions is their impact on employee loyalty. The concept of employee loyalty itself evades definition, but it does seem to have more than average relevance to the chemical industry, which traditionally has been considered a highly paternalistic business in which one-company careers are the norm rather than the exception.

The chemical industry's professionals have had their feelings of security shaken before—in the early 1970s, in 1975, and earlier in this decade. But all those employment cutbacks coincided with economic recessions. Last year's broad assault on the salaried work force came during a period of economic growth, albeit slowing.

"The loyalty question is coming up more often," says McCarthy of Hercules. "When you're 25 to 30 years old, and this guy who spent 30 years with the company ends up losing his job or being strongly encouraged to retire at 55, you say, 'How much security do I have?'"

Audrey Freedman, executive director of the Conference Board's human resources program, remarks: "It used to be that if you offered loyalty and support and, to some extent, ceded your good judgment to the company, the company would take care of you. That kind of exchange is not thinkable any longer for most companies, even those that are not restructuring."

Hercules' McCarthy asserts that this general comment does not apply entirely to chemical employees. "I still think the mentality in the chemical industry is that you join a company off the campus and that, more than likely, that company will be your career-long employer," he says. He acknowledges, however, that this attitude is not indestructible. "The reductions in force could tear that fabric, but it will be years before we find out."

McCarthy: continuity of know-how

Lamalie's Johnson is less equivocating. "The day of the one-company career is without question over," he declares.

Not that corporate leanness is the only reason for that. Observers also note the more independent attitude of younger employees toward their employers. "Companies will never have the same kind of loyalty in their executive work forces as in the 1950s," Johnson says. "The value system of the worker in his thirties has changed." If anything, the two trends—less corporate paternalism and greater employee independence—have coincided and, in doing so, have been mutually reinforcing.

Furthermore, from the management point of view, disruption of the old system of assumptions tied to employee loyalty can be beneficial. "One problem with managers full of loyalty is that you get a great suspension of critical thinking," points out the Conference Board's Freedman. "The watchword becomes, 'Find a mentor and brownnose him to death.' That produces a roomful of so-called managers who do nothing but ratify each other's judgments."

Nonetheless, chemical firms realize they must maintain and, in light of this decade's job dislocations, revitalize morale. At Hercules, for example, management is meeting more frequently with employees to listen to their job concerns. "I think we are becoming more enlightened about how valuable the feelings of our employees can be if they are positive," McCarthy says.

Says Lamalie's Johnson: "It will be incumbent on the employer to instill a level of confidence that there will be opportunities for people in the company."

And Freedman, in comments on the Conference Board's 1986 labor outlook report published late last year, believes that the ultimate impact of the past few years' work-force cuts is not yet apparent. "Today young managers and older ones can assume nothing about the reliability of regular career advancement. Traditional corporate cultures of security, especially for salaried workers, are shattered." □

Hazardous Wastes In Academic Labs

Howard J. Sanders, C&EN Washington

Rising on the campus of Stanford University, in a picturesque meadow near the university's historic bright-red equestrian stables, is an unusual facility for treating and disposing of hazardous chemical and biological wastes. The $7 million installation, which is expected to begin operating in September, will consist of three adjacent buildings.

One building will contain facilities for handling infectious biological wastes (mainly from the university's hospital) and chemical wastes, as well as an incinerator and a laboratory. Another building will house several laboratories and a facility for handling low-level radioactive wastes. The third building will contain administrative offices and a center for the safety training of students and professionals. The complex probably will be the largest, most modern, and most well-coordinated installation of its kind on any campus in the U.S.

Alain DeCleve, director of Stanford's department of health and safety, comments, "The new centralized installation, which will replace facilities scattered throughout the campus, should increase substantially the safety and efficiency of our hazardous waste management program. We are especially pleased that the new facility will include separate handling areas for different types of waste materials, an environmentally

sound high-temperature incinerator, a fail-safe system for spill control, and stringent safeguards in the event of a fire or earthquake."

The Stanford facility is a striking example of efforts now under way at colleges and universities to improve their disposal of hazardous wastes. One reason for this growing activity is the increasing regulation of hazardous waste disposal by the federal government and the states. The Resource Conservation & Recovery Act (RCRA), whose regulations took effect in 1980, initially applied fully only to installations that generated 1000 kg or more of hazardous waste per month. After March 31, however, the law will apply to an increased extent (but not fully) to generators that produce more than 100 kg but less than 1000 kg per month of such wastes. According to one estimate, this change will raise the number of schools under more-than-nominal RCRA regulation by about 1500.

Academic institutions also must comply with the federal Comprehensive Environmental Response, Compensation & Liability Act (commonly known as Superfund), passed in 1980. Under this law, organizations that have disposed of hazardous waste improperly in waste dumps are required to clean them up, which can be expensive. Although this law has applied mainly to companies, the University of Minnesota and North Carolina State University have been placed on Superfund's National Priorities List for cleanup of specific disposal sites they used in the past.

Colleges and universities also are becoming increasingly aware that, even if they turn their hazardous waste over to a commercial disposal firm, they are still liable for any health or environmental damage the stored waste might eventually inflict. This, in turn, is causing schools to be extremely cautious in selecting a disposal firm to handle their hazardous wastes.

As part of their expanding waste management programs, many schools are recovering useful materials from hazardous wastes and, at the same time, reducing the volume of such wastes that must be disposed of. In part, this is cutting down the cost of waste disposal, which is becoming more and more expensive.

Russell W. Phifer, special services market manager at Resource Technology Services in Devon, Pa., estimates that in recent years the cost of off-site hazardous waste disposal has been increasing at a rate of at least 10% a year. The cost of organic laboratory chemicals, he believes, has been growing at least 5 to 10% a year.

Many schools, and especially chemistry departments, also recognize that training in the disposal of hazardous wastes is an essential part of a chemistry student's education. Ralph O. Allen, a chemistry professor at the University of Virginia, says, "We can seize upon this opportunity to teach our students more about safety, chemistry, and good citizenship."

In years past, many academic laboratories (as well as industrial laboratories) did very poor jobs of hazardous waste disposal. University students and their professors frequently poured waste chemicals down the drain or threw them into garbage bins. Professors, their assistants, or custodial people might just pour the chemicals on the ground in some isolated spot or in a quarry or a waterway. At many schools, some of these practices still go on.

Industrial hygienist examines containers of waste materials gathered from a university chemistry lab

A bottle of waste mercuric sulfate is added to other discarded chemicals placed in a lab pack

Another problem at colleges and universities has been the tendency of many professors to store sizable amounts of chemicals on lab shelves for 10, 20, or more years—long after they have ceased to be of any use, and some may actually have seriously or dangerously deteriorated.

Recently, a small college in central Pennsylvania replaced a 100-year-old chemistry building with a new one. A huge amount of stored chemicals, including reactive and explosive materials, had to be disposed of before the old building could be torn down. The disposal operation alone cost $35,000.

The question of how good a job colleges and universities are doing today in managing hazardous waste is difficult to answer, because the effectiveness of hazardous waste management programs varies enormously from school to school. In fact, some schools have essentially no program at all.

Martha A. Anderson, director of the University of Arizona's department of risk management and safety, believes that the larger research-oriented universities in the country are doing an excellent job of hazardous waste management. She is very concerned, however, about the programs at smaller colleges and universities. She believes that many professors are so absorbed in research and teaching that they place a very low priority on hazardous waste disposal.

The environmental safety officers of some large universities, as well as some environmental safety consultants, often make scathing remarks about how hazardous waste disposal is conducted at many small colleges. But they also note that, although hazardous waste disposal currently is handled quite poorly in many schools, the situation is improving. Schools are increasingly aware of the need to improve waste disposal practices and of the impact of hazardous wastes on human life and the environment.

Important to note is the fact that most colleges and universities, including the largest ones, do not perform the ultimate task of disposing of hazardous wastes. The schools segregate wastes by type, assemble them for pickup, and sometimes package them in special drums. But the job of treating, storing, and disposing of the waste is often left to a commercial firm that specializes in this type of work.

In coping with hazardous waste disposal, many schools, especially small ones, face myriad problems. Finding the funds to do a proper job of hazardous waste disposal is difficult. Some critics, however, argue that the problem is not so much a matter of a shortage of money as it is a shortage of motivation. Howard H. Fawcett, a chemical health and safety consultant in Wheaton, Md., declares, "If the smaller schools had a real desire to do a good job, they could find the money somewhere. Often, the amount of money needed is not all that great—perhaps a few thousand dollars a year."

Another problem is that many small schools have no one working even part-time to coordinate the waste management program. In some schools, the person in charge of hazardous waste management is merely a member of the campus security force who is far more concerned about the theft of word processors from the administrative offices or the spraying of graffiti on campus buildings.

Alan S. Corson, chief of the studies and methods branch of the Office of Solid Waste at the Environmental Protection Agency (EPA), believes that many schools have only a vague idea of what RCRA or the states require in the way of hazardous waste management. "They often do not realize what their legal obligations are," he says. "And some schools are under the misguided impression that Congress never intended the law to apply to colleges and universities." He adds, "To someone not accustomed to reading government regulations, which sometimes are quite convoluted, the RCRA requirements are admittedly not easy to understand."

Because many schools generate relatively little haz-

Vermiculite poured into a lab pack will reduce breakage and absorb any liquid that may be released if a container inside does break

Label is attached to indicate that drum contains hazardous waste

ardous waste, federal and state regulatory agencies have largely ignored most of them. As a result, some schools have felt no great compulsion to adhere to the law.

Laboratories in industry generally are considered to do a better job of waste management than those in academia. They usually have more money to spend on waste management than do academic labs. And directors of industrial labs usually get stronger backing from top managements for effective waste control than do the heads of academic departments. One reason is the companies' greater concern about their long-term financial liability.

Many academic research groups, in fact, regard themselves as essentially autonomous and operate with relatively little outside supervision. As a result, they may not pay attention to instructions from a department head or from the director of the university's environmental safety office. Industrial scientists are likely to be much more accustomed to following instructions from higher levels in the organization.

Aaron K. Furr, head of the department of health and safety at Virginia Polytechnic Institute & State University, observes, "Whether individuals are insensitive to environmental concerns or whether they simply feel that such issues interfere with their academic freedom, a campus program may be met with considerable resistance."

Another observer adds, "Industrial laboratories have had a long-standing reputation for being more safety conscious than academic labs. In industry, people who repeatedly disobey safety rules get fired. In universities, some professors take an extremely cavalier attitude toward the matter because, after all, they have tenure."

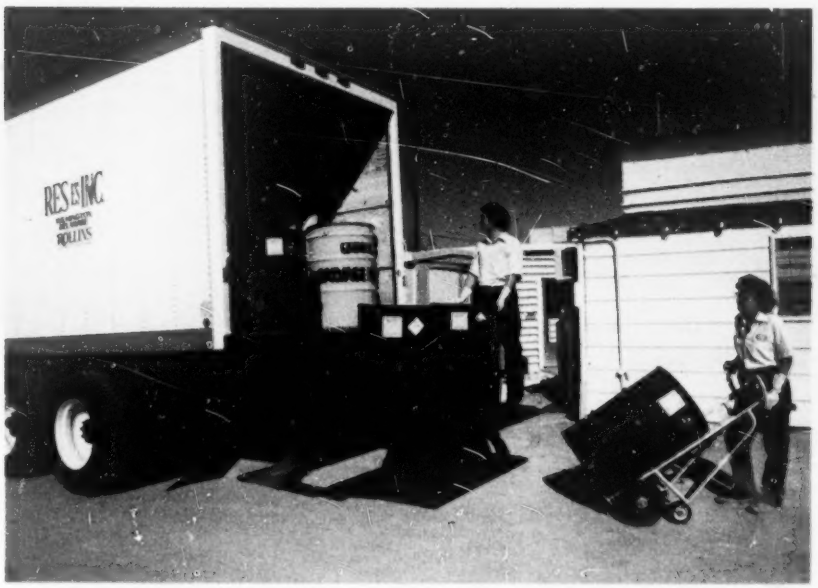
Jay A. Young, a chemical safety and health consultant in Silver Spring, Md., declares, "When it comes to the operation of hazardous waste management programs, some professors can get quite obstructive because of their absurd assumption that they know much more about the problem than do the university's environmental safety experts. You find this attitude much less often in industry."

As hazardous waste generators, academic labs, of course, are very different from industrial plants. Academic labs generate only a very small percentage of the total amount of hazardous wastes produced in the U.S. According to EPA, generators of less than 1000 kg per month of hazardous waste—a category into which most academic labs fall—account for just 0.4% of all such waste, or only about 940,000 metric tons a year.

On the other hand, academic laboratories produce an exceptionally large variety of waste. An industrial plant may generate only a dozen or so waste products. An academic laboratory may generate thousands of such products, some in only gram quantities. Not only is the waste varied but it continually changes in composition as new research projects are started, older projects terminated, and the direction of research programs shifted.

For example, in 1984 the University of Illinois disposed of 7300 containers holding more than 2100 different chemicals and chemical mixtures. The University of Massachusetts, Amherst, annually disposes of about 2000 different chemicals and chemical mixtures. They range in amounts as small as an ampoule to as large as a 55-gal drum.

This wide diversity of chemicals is a major problem, partly because EPA requires that all chemicals buried in landfills be identified by chemical name. The identification of wastes, which may require chemical analysis if identifying labels are missing, obviously is a more



Drums of packaged and identified hazardous wastes (above) are loaded on a truck that will transport them to a landfill (right), where they will be buried

complex, expensive, and time-consuming job for an academic lab than for an industrial plant that generates only a few types of waste. The cost of having a waste analyzed in a university lab typically ranges from $30 to $50.

In addition, the great variety of waste generated by academic labs requires them to do an exceptional amount of paperwork to keep tabs on what they ship to off-site disposal facilities. This also is a serious problem for waste disposal firms. The waste disposal firm that Washington State University has used for many years recently notified the university that it no longer would handle the school's hazardous waste. The company claimed that, although the university's waste represented only about 1% of the company's business, it accounted for about 99% of its problems.

The hazardous wastes generated by academic labs run the gamut from organic solvents, heavy metals, and explosives to flammable compounds, toxic materials, corrosive substances, and carcinogens. Typically, the largest volume of waste generated by these labs consists of organic solvents.

EPA has established special rules for so-called "acutely hazardous wastes" that, unlike those that have chronic toxicity, can cause serious harm from a single or a short-duration exposure. Among such chemicals are sodium cyanide, carbon disulfide, fluorine, arsenic trioxide, and mercury fulminate.

EPA may allow a facility to store, for example, up to 100 kg of an ordinary hazardous waste without a permit. However, it will allow the storage without a permit of no more than 1 kg of a waste that is acutely hazardous.

The amount of hazardous waste chemicals generated at some universities is larger than might be imagined. And the amount is growing. For instance, in 1984 the University of Illinois campus generated about 27,500 kg of such chemicals. In 1985, the amount climbed to 37,000 kg. The University of Wisconsin, Madison, disposed of about 50,000 kg of such waste in 1984 and about 105,000 kg last year. The University of Maryland, College Park, increased its hazardous waste shipments to an outside disposal firm from about 150 55-gal drums in 1980 to 320 drums last year.

One of the major problems that colleges and universities are facing is the rising cost of their hazardous waste disposal programs. The University of Illinois spent about $2000 to dispose of 100 drums of waste chemicals in 1977. By 1982, its cost of disposing of 265 drums was $46,000 (or more than $17,000 per 100 drums). By 1985, the cost of disposing of 216 drums was $51,000 (or about $24,000 per 100 drums).

In 1985, the University of Virginia spent about $17,000 to have part of its hazardous waste disposed of by a commercial firm. This waste was only about one third of the total generated by the university, since the remainder was handled by the school's own recovery and treatment procedures. In contrast, the university spent only about $7000 in 1980 to have all of its hazardous waste disposed of by an outside firm.

In late 1983, Richard S. Holdstock in the environmental health and safety office at the University of California, Davis, estimated that the cost of collecting and removing hazardous waste from the campus had grown 113% in the previous five years. The principal reasons for this rise were the increases in labor costs and in the volume of waste handled. He estimated that the total cost of collecting, storing, segregating, packaging, shipping, and disposing of hazardous waste in a single 55-gal drum was about $104 (a cost that has risen considerably since then). Of this dollar amount, 43% represented the cost of labor.

John P. Nemergut of Science & Engineering Associates, a research organization in Albuquerque involved in hazardous waste management and environmental planning, comments, "Transportation and disposal costs of hazardous wastes have skyrocketed to a point where, for some chemicals, they actually can exceed their purchase price."

Paying for hazardous waste disposal

At the vast majority of colleges and universities, the cost of hazardous waste disposal is treated as a general operating expense. One reason for dealing with hazardous waste disposal as an indirect cost is the difficulty in determining exactly how much of the total cost should be assigned to each academic department.

In recent years, a growing number of people have been arguing that the cost of hazardous waste disposal should be treated, instead, as a direct cost that can be tied to a department's operations. They say that it is unfair to charge the English department, for example, for the cost of hazardous waste disposal or even to charge the physics department almost as much as the chemistry department, which may produce far more such waste.

On the other hand, when waste disposal is treated as an indirect cost, scientists are encouraged to use the

Sites at two universities are on Superfund high-priority list for cleanup of wastes

The Environmental Protection Agency has placed both the University of Minnesota and North Carolina State University on its Superfund National Priorities List that calls for the cleanup of sites used for disposal of hazardous wastes in the past. Of the two schools, Minnesota is taking action to remedy the situation, and North Carolina has rejected EPA's allegations.

Between 1960 and 1974, the University of Minnesota burned chemical laboratory wastes in an outdoor pit at its Rosemount Research Center in Rosemount, Minn., about 25 miles south of St. Paul. The university stopped the practice in 1974 when it began sending its hazardous wastes to an outside company for disposal. Subsequently, the pit was covered over.

In 1984, the Minnesota Pollution Control Agency, which handles the state's EPA program, found that groundwater as far as 2 miles to the northeast of the disposal site was contaminated with low levels (less than 15 ppb) of chloroform. About 30 families live in this contaminated area. The agency advised the families to stop using well water because, among other things, chloroform can cause liver damage. The university, at the request of the Minnesota Department of Health, began supplying the families with bottled water for drinking and cooking.

The university has suggested several ways of solving the water contamination problem. Fay M. Thompson, the university's hazardous waste officer, regards three as especially promising.

One is to install charcoal filters at each home to adsorb the chloroform. Another is to drill near each house a new well deep enough so that its water contains no chloroform. A third possibility is to set up a community supply system that obtains water from outside the contaminated zone. No decision has yet been made by the pollution control agency in cooperation with the state's health department.

Chloroform, unlike many organic compounds, does not biodegrade once it gets into the ground. And because it is water soluble, it can readily enter underground water supplies. Hence, although many chemicals were placed in the Rosemount burning pit, only chloroform appears to have seeped out in hazardous concentrations. Thompson expects the university's problem to be solved by the fall of this year.

Bruce S. Davis, a project manager at the Minnesota Pollution Control Agency, says that, actually, a number of other chemicals, such as carbon tetrachloride, 1,2-dichloroethane, and 1,1-dichloroethylene, also have been found in groundwater in the vicinity of the burning pit, but in concentrations that are permissible in drinking water.

Several other waste disposal sites at Rosemount currently are being investi-

best methods available for dealing with it because the disposal will cost them the same, regardless of what practice they follow. In other words, the indirect-cost system discourages people from flushing chemicals down a drain just to reduce their hazardous waste disposal costs.

Some schools, particularly smaller ones, have undertaken cooperative ventures to reduce their waste disposal costs. Schools in a given region use the same waste disposal company, which operates along a single designated route. Such a system reduces transportation costs because waste haulers often charge as much for transporting one drum of waste as they do for transporting a dozen. It also may enable the disposal firm to lower its price per drum because it is dealing with a larger volume of waste.

One of the more ambitious cooperative projects for hazardous waste disposal has been under way since 1981 in Minnesota, where high schools were accumulating sizable amounts of hazardous chemicals that they did not know how to get rid of.

The Minnesota Chemical Waste Assistance Project now serves about 160 high schools and 20 colleges throughout the state. The schools periodically bring their hazardous waste to any one of five regional collection sites, where people from the University of Minnesota pick it up and ship it to the university for handling. The program, which last year cost the participating schools about $50,000, enables small schools to dispose of their hazardous waste safely at relatively low cost. In addition, a program has been set up so that schools needing specific chemicals can obtain them without cost from schools that want to get rid of them.

To manage hazardous waste chemicals on college and university campuses, the waste first must be assembled at one or more locations, segregated by type, and, if necessary, labeled. After the material has been stored on campus usually for no more than 90 days, it is picked up by a waste transporting firm or by a waste disposal firm.

Before being transported off the campus, the waste containers usually are placed in 55-gal drums, which can be buried in landfills. In some cases, the waste is treated to reduce its volume or to make it less hazardous before it is buried.

Use of lab packs

In early 1985, EPA began prohibiting the burial of hazardous liquid wastes in landfills. This ruling, however, did not affect the previous EPA regulation, issued in late 1981, that allowed the burial of laboratory-generated liquids (as well as solids) in lab packs.

The lab-pack ruling, which recognized the special problems of labs, is encouraging to many lab people who think that EPA also should ease some other rules that place excessive burdens on lab operations.

A lab pack is a 55-gal drum that is capable of holding no more than 15 gal of liquid waste in bottles or cans. The remaining content of the drum consists of an inert, absorbent material, which is usually vermiculite but also can be diatomaceous earth or fuller's earth.

The filler material reduces the possibility that the containers will break by accidentally hitting one another. It also can absorb any liquid that is released if a

gated by the pollution control agency. These, however, are not expected to be so serious a health or environmental problem as the one primarily involving chloroform.

The issue at North Carolina State University stems from the fact that a large variety of bottles, cans, and other containers of waste chemicals were buried between 1969 and 1980 at an off-campus site about a half-mile north of its Carter-Finley Stadium. These materials, which came from the school's science laboratories and agricultural research facilities, included organic solvents, pesticides, heavy metals, acids, and bases.

In 1982, the university's department of marine, earth, and atmospheric sciences began drilling a series of wells near the disposal site to determine whether the groundwater contained hazardous chemicals. To date, it has drilled 24 wells to depths ranging from 30 to 65 feet. Shortly after it began its test program, the department found that the water contained relatively high concentrations of such compounds as chloroform, bromoform, 1,1,1-trichloroethane, and methylene chloride.

Test wells have been drilled as far as 250 feet from the disposal site. According to Charles W. Welby, a hydrogeology professor at the university, the contaminating chemicals have been found only at distances of less than 100 feet from the disposal site.

This location, he emphasizes, is almost completely surrounded by state-owned property and consists largely of forested and grassy areas. No homes are on this land. On the other hand, parts of the area are used for parking cars, especially during football games.

NC State has appealed EPA's designation of its disposal area as a Superfund site and has asked to be removed from the National Priorities List, which identifies sites for long-term cleanup. Welby says that the school has received no formal response from EPA regarding this appeal. The university is monitoring key wells near the site to determine the water's concentration of specific organic chemicals. Welby declares, "We are confident that the groundwater contamination is having no impact on human health. The nearest family that could possibly be affected is more than a mile away from the disposal site. And the contamination plume goes out for less than 100 feet—in a direction away from the populated area."

Nevertheless, Al J. Smith, a Superfund coordinator in EPA's Atlanta office, says the agency still regards the NC State site as a potential hazard to health and the environment. He stresses that the plume can spread in the future. Moreover, the university someday may wish to use the area for purposes that could be endangered by the underground contamination.

container breaks—liquid that otherwise might leak out of the drum. Lab packs are used both to transport discarded chemicals to a waste disposer and to hold the chemicals when deposited in a landfill or placed in an incinerator.

If the drum will be buried in a landfill, it must be made of metal. However, if it will go into an incinerator, it can be made of fiberboard or other burnable material.

The drum must hold only materials that are chemically compatible. Moreover, they cannot contain such unusually dangerous materials as organic peroxides, reactive metals, or explosives.

The majority of hazardous waste from laboratories now is buried in lab packs. The method is relatively simple and, compared to incineration, fairly inexpensive. On the other hand, lab packs usually cost anywhere from $300 to $400 each, including the cost of the drum and the absorbent filler and the costs of packing, inventorying, shipping, and burying it. The cost of packing, shipping, and disposing of lab packs has increased about two- to threefold in the past four years. Moreover, some waste disposal firms refuse to handle only one or two lab packs or they may charge as much for shipping five drums as for shipping a full truckload.

Some universities pack their own lab packs to save money. But many waste disposal firms insist on packing all the lab packs they accept. This not only increases their profits but it ensures that the job will be done correctly.

Not long ago, a shudder went through the waste management industry when one disposal company in New Jersey that had not packed the lab packs it handled incinerated the contents of one of them. Because the company did not realize that the drum improperly contained an explosive, a costly incinerator was demolished.

Many waste management experts have misgivings about burying lab packs in landfills. They point out that the method does not really dispose of the wastes; it merely hides them. In addition, it is becoming an increasing financial burden. And even though lab packs generally are regarded as safe storage containers, it is always possible that some may leak.

One alternative, however, is incineration, which is decidedly expensive. For example, the incinerator currently being built at Stanford to handle up to 1000 lb of solid and liquid wastes an hour will cost about $850,000, including the cost of a wet scrubber and instrumentation. Use of incinerators is expensive not only because of the equipment but because of the cost of the skilled labor required to operate them, the cost of the fuel needed to heat them, and the cost of carrying out the elaborate, time-consuming tests needed to get an EPA or state permit for their use. In addition, the resulting ash, which contains salts, metals, and other noncombustibles, usually must be stored in a landfill.

To win EPA approval, an incinerator must destroy or remove 99.99% of the principal organic hazardous constituents of the waste. And getting EPA's approval is far from easy. For one thing, the repeated test burns that must be carried out before EPA is satisfied that an incinerator is working properly may take a year or

more. The head of an environmental safety department at a large university groans, "Frankly, the job of getting our incinerator permit nearly killed me!"

Despite the hassle, a few large schools, such as the University of Wisconsin and the University of Arizona, already have installed a waste incinerator on or near their campuses. The University of California system is looking into the possibility of building several regional incinerators to destroy the hazardous wastes from its numerous campuses.

But one university expert concludes that the majority of academic institutions cannot afford to operate their own incinerators for hazardous waste disposal. Recognizing, however, that the method has many environmental advantages, he recommends that several schools within a relatively limited area jointly install a single incinerator for their cooperative use.

Some large schools have disposed of some flammable waste solvents in the past by adding them to the fuel oil used to heat steam boilers, power generators, or incinerators.

This practice, however, is declining, mainly because of increased regulation by federal and state agencies. Also, the practice may involve more cost and effort for schools than it is worth.

Starting in 1982, the University of Virginia got rid of its waste xylene by burning it as a secondary fuel to heat the incinerator it used to destroy pathological wastes. Now, the university finds it more practical to give its waste xylene and other flammable solvents away free to a company that adds them to its heating fuel.

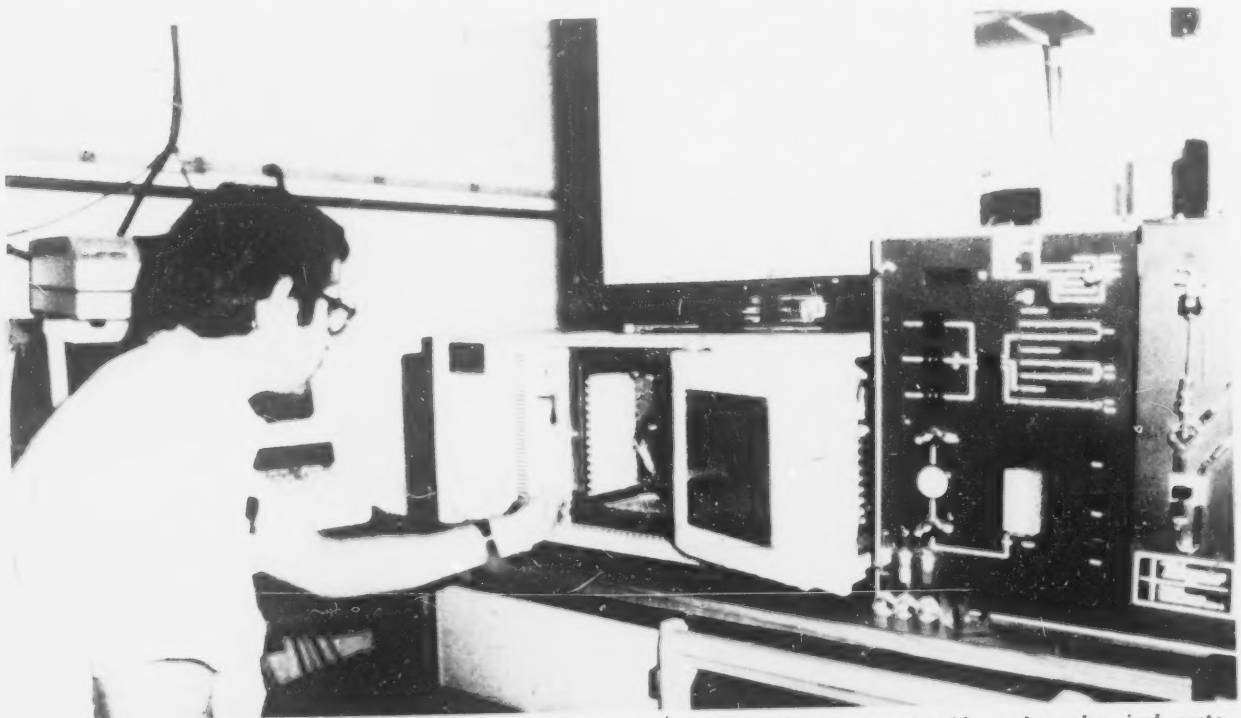
Some years ago, Texas A&M University used such flammable waste chemicals as acetone and methanol to augment the fuel oil used to heat an incinerator. Last September, however, the university discontinued this practice when Texas enforced regulations stating that only boilers or industrial furnaces (but not incinerators) can be used without a RCRA permit to recover energy by the burning of flammable hazardous wastes.

Another way to reduce waste is to use electrolysis where feasible. Schools that have large photographic and x-ray facilities use electrolysis to recover valuable silver, for example. Other major schools send silver-containing solutions to commercial firms that specialize in recovering this metal.

Laboratories at a number of schools, including Southern Illinois University, Iowa State University, and the University of Arizona, decrease the volume of their hazardous waste by evaporating water or other solvents. The volume of aqueous solutions containing ions of such metals as chromium, lead, copper, and selenium can be greatly reduced by placing them in evaporating pans out-of-doors in warm weather (protected from the rain). The method, however, is quite time consuming.

Some labs also remove volatile solvents such as ethers by evaporating them in fume hoods. This procedure, however, can contaminate the outside air or pose a fire hazard.

A common way to destroy hazardous waste is to react waste acids and bases and thus neutralize them. If aqueous solutions fall within the pH range of 2 to 12.5 and do not contain any of the specified forbidden compounds, they can be poured down a drain, perhaps after being diluted.



A chemist at Rollins Environmental Services in Logan Township, N.J. analyzes a sample of hazardous chemical waste

At some universities, the hazardous waste office will not accept waste acids and bases. They must be neutralized in the lab and disposed of in a sewer. If not enough discarded base is available to treat the waste acid, a relatively inexpensive base such as sodium bicarbonate is used.

Organic solvents often are recovered from contaminated solvents by distillation, both to lessen the amount of chemicals that need to be purchased and to reduce the cost of hazardous waste disposal. But many schools do not want to get involved in distilling waste solvents because the job is time consuming and costly and many solvents are quite flammable.

RCRA requires that anyone who operates a facility for treating specified hazardous wastes must have an EPA or state permit. Such treatment procedures include distillation, neutralization, evaporation, and chemical conversion. However, these rules frequently are ignored by academic labs. Moreover, EPA has not been particularly diligent in imposing its rules on academic labs because they generate so relatively little hazardous waste.

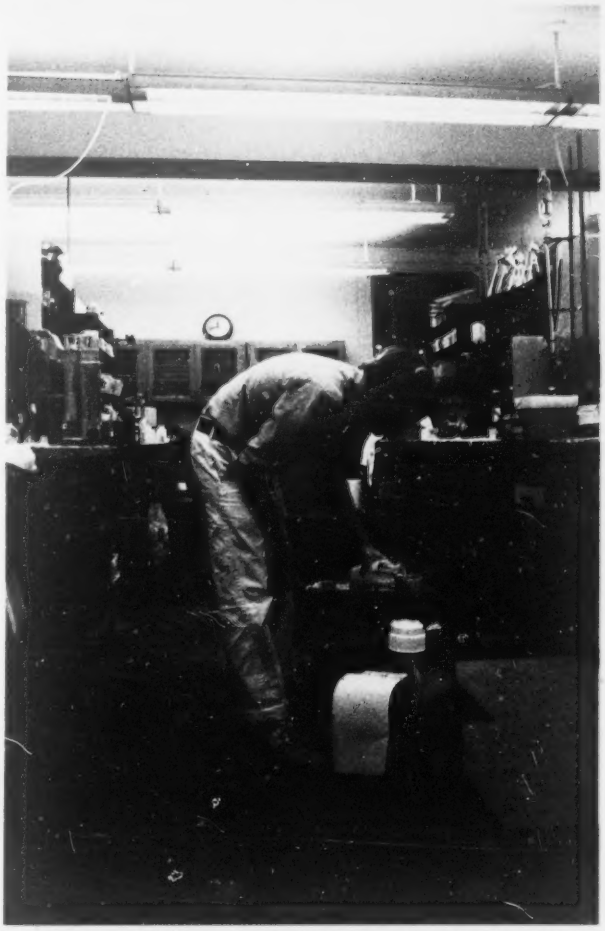
In some cases, toxic chemicals can be converted to nontoxic compounds. One example is a cyanide salt, which may be detoxified in the lab by treating it with an oxidizing agent such as sodium or calcium hypochlorite to produce a biodegradable cyanate. (This, of course, must be done under proper ventilation to avoid exposure to the poisonous cyanide.) The resulting cyanate usually can be flushed down the drain.

Relatively few academic labs, however, follow such a procedure. The time and effort involved are considerable. And many scientists are reluctant to deal, any more than absolutely necessary, with substances as toxic as cyanides. On the other hand, the new hazardous waste facility being built at Stanford will include a laboratory where poisonous compounds such as cyanides and carbon disulfide will be converted to nontoxic substances before disposal.

The University of Wisconsin has a centralized facility that, among other things, detoxifies hazardous wastes. For example, it uses saponification to detoxify organophosphate pesticides. The facility also contains labs that can neutralize acids and bases, reduce oxidizing agents, or precipitate heavy metals. The installation has applied for an EPA permit to carry out such procedures.

Wastes containing explosive chemicals present special problems to schools. Among such compounds are picric acid, organic peroxides, perchlorates, hydrazine compounds, and ethers that have deteriorated to form explosive peroxides. These dangerous materials are not permitted to be buried in landfills. Furthermore, many waste disposal firms will not handle them. Those that do may charge as much as $500 a lb to dispose of them because of the risks involved and the high cost of liability insurance.

Some academic labs donate their explosive chemicals to the bomb squad of their local police department for training purposes. One school in the Boston area, however, ran into trouble when it repeatedly turned over its explosive compounds to a nearby Army depot for detonation without being charged for the service. A Boston company that specializes in disposing of explosive chemicals successfully sued the Army for unfairly taking away part of its business.



University of Wisconsin student pours waste solvent into carboy for disposal in university's incinerator

Universities can cut down their volume of discarded chemicals by operating systems to transfer chemicals from people who no longer need them to people who do. Russell Phifer of Resource Technology Services estimates that about 30 to 40% of all unused reagents can be used by another lab possibly within the same organization. Peter C. Ashbrook, head of hazardous waste management at the University of Illinois, says, "A surprising amount of the chemicals we receive for disposal are perfectly good—sometimes even in unopened containers. For more than 20 years now, our organic chemistry department has operated, on a voluntary basis, a stockroom containing usable chemicals that some of our scientists no longer want."

A chemical exchange program at the University of Massachusetts, Amherst, has been operating effectively for more than three years. As part of this effort, the environmental health and safety division issues a bulletin every two or three months to notify the school's scientists and engineers of the chemicals that are available. The program has saved the university more than $30,000 in the cost of new chemicals and of hazardous waste disposal by an outside firm.

A similar program has been under way at the University of Wisconsin since 1980. The hazardous waste office distributes a list of available donated chemicals five times a year. The project, says Peter A. Reinhardt, supervisor of the hazardous waste program, saves the school more than $20,000 a year by reducing chemical purchases and the costs of waste disposal.

About twice a year, Cornell University's chemistry department issues a list indicating what excess chemicals are available free from various members of the department.

Many researchers, however, may not want to run the risk of jeopardizing the success of an experiment by using a chemical that was not obtained recently in an unopened bottle from a chemical supplier. "Researchers clearly demand chemicals of known provenance," declares consultant Jay Young.

Edward W. Blackburn, director of the department of environmental safety at the University of Maryland, says that in 1980 the university began a program of collecting unopened bottles of excess chemicals and offering them free to other labs on the campus. The program, however, was discontinued after only about seven months because the faculty response was keenly disappointing. He believes the main stumbling block was that the university's scientists and engineers, by and large, want to use only freshly bought chemicals of unquestioned purity. He also emphasizes that the operation of a chemical exchange program is time-consuming and laborious.

Partly to reduce their volume of hazardous wastes, chemistry departments at some colleges and universities have been introducing lab courses that call for the use of unusually small amounts of chemicals. The scaled-down experiments also reduce the cost of needed reagents and permit experiments to be carried out that otherwise would be too expensive because of the high cost of the chemicals required.

Several years ago, Dana W. Mayo, a chemistry professor at Bowdoin College, and a pioneer in this area, developed an undergraduate organic chemistry lab course in which the volume of starting chemicals is one hundredth or less of the amount conventionally used. For the past two years, Princeton University has been using microscale experiments in its freshman inorganic chemistry lab courses. And Cornell University this semester decreased the scale of all of its undergraduate organic lab experiments one fifth to one tenth of the customary level. "We think this is an important step in the right direction," says Earl Peters, executive director of the chemistry department.

Miles Pickering of Princeton's chemistry department emphasizes that microscale experiments are cheaper and safer than conventional ones. "Twenty grams of potassium cyanide is a serious hazard, whereas 100 mg is not likely to kill anyone." Pickering also points out that, when experiments are done on a small scale, reactions go faster, as do separation procedures.

Professors in some schools, however, are dubious about the practicability of introducing microscale experiments. Many students would be frustrated by such experiments, because they lack the manual dexterity to carry out the experiments successfully.

Many colleges and universities believe that some of EPA's RCRA regulations are too stringent for laboratories, as are state regulations patterned after those developed by EPA. They stress that RCRA was enacted almost entirely with industrial hazardous waste disposal in mind. They contend that rules that are perfectly justifiable for industrial plants, which generate tons of hazardous wastes, often are unreasonable for labs, especially those in academia.

Kathleen A. Ream, head of the American Chemical Society's department of government relations and science policy, asserts, "No one argues about whether there is a need for RCRA. Arguments can be made, however, that the burdensome nature of many of its regulations, which were designed with manufacturing or processing operations in mind, have hindered the primary function of laboratories—to advance scientific knowledge—while contributing relatively little to safe waste disposal."

One of the most frequently heard complaints is that EPA's regulations under RCRA demand an excessive amount of detail regarding the chemical composition of hazardous wastes generated by labs.

William G. Mikell, environmental control manager at Du Pont, says, "Even small-quantity generators, who are exempt from many RCRA regulations, may find that, when they go to ship their waste for disposal, they must describe it in some detail. This requirement on small-quantity research samples seems like overkill."

Phifer of Resource Technology Services comments, "The costly analytical testing of complex laboratory samples is a ridiculous way to use up a budget for waste disposal."

Various scientists concerned with environmental health and safety have been recommending that lab packs be required to identify their contents only by broad categories, such as corrosive acids, corrosive alkalies, oxidizing agents, flammable liquids, flammable solids, water-reactive compounds, polymerizable compounds, reactive organic peroxides, or toxic wastes. Such a change would reduce the amount of analytical work that colleges and universities are now required to do. Also, it would reduce the amount of paperwork that EPA would have to deal with.

Most hazardous waste is produced by largest generators

Hazardous waste generated per month	Number of hazardous waste generators	% of total	Amount of hazardous waste generated (metric tons per year)	% of total
1000 kg or more	14,100	2.2%	264,000,000	99.6%
More than 100 kg but less than 1000 kg	175,000	27.4	700,000	0.3
100 kg or less	450,000	70.4	240,000	0.1
TOTAL	**639,100**	**100.0%**	**264,940,000**	**100.0%**

Source: Environmental Protection Agency estimates

Explosive wastes from University of Maryland are placed in this pit before they are detonated

But other environmental safety people are opposed to the use of broad chemical categories to identify hazardous wastes. Lawrence A. Holbrook, head of the hazardous waste management section of the University of Maryland's department of environmental safety, declares, "Broad classifications do not provide enough specific information to assist people in determining a material's full adverse effects on the environment. Many chemicals have more than one property. For example, crotonaldehyde, although officially classified as a flammable liquid, is also toxic. Hence, if you categorize a lab pack containing this chemical and other such liquids as holding only flammable materials, you may not realize that at least some of the contents are also poisonous."

Others believe that EPA should relax its rules governing its granting of permits to universities that want to operate their own incinerators for disposing of hazardous wastes. They believe that schools should be allowed to operate incinerators handling less than 25 kg per hour under less stringent requirements.

Present rules regarding the on-campus location of such units, the instrumentation required, and the testing necessary, they believe, are excessive. Says one university official, "Given the comparatively small quantities of waste involved on college campuses, it might be reasonable for EPA to relax its present standards requiring 99.99% destruction efficiency for all incinerators, including the relatively small ones."

EPA currently is considering the possibility of making its requirements for small incinerators less strict than for larger facilities. Academic people also argue that EPA should eliminate some of its rules requiring universities to have permits to treat hazardous wastes. In recent years, ACS has taken an active role in pointing out to EPA and other government agencies the special problems that laboratories have in dealing with government regulations covering hazardous waste. ACS has submitted a number of suggestions to EPA on how it can protect human health and the environment without imposing unreasonable hardships on labs.

It encouraged EPA, for example, to allow liquid hazardous wastes to be buried in landfills, provided they are stored in approved lab packs. It also has urged revision of other EPA regulations to make them more appropriate for labs. Some of these recommendations are currently under the agency's active consideration.

In late 1981, ACS established its Task Force on RCRA, headed by Stanley H. Pine of California State University, Los Angeles, as a joint effort of the ACS Committees on Chemical Safety, on Chemistry & Public Affairs, and on Environmental Improvement. Last year, the task force issued a 16-page booklet called "Less Is Better: Laboratory Chemical Management for Waste Reduction." (Single copies are available free by writing to the Office of Federal Regulatory Programs, American Chemical Society, 1155—16th St., N.W., Washington, D.C. 20036.) □

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